



# Cook Stoves & Indoor Air

Promoting Clean and Efficient Cooking in the Developing World



## Charcoal Briquette Enterprise Development: *Lessons from the Harvest Fuel Initiative* March 5<sup>th</sup>, 2014



**HARVEST FUEL**  
*Initiative*



# Today's Speakers

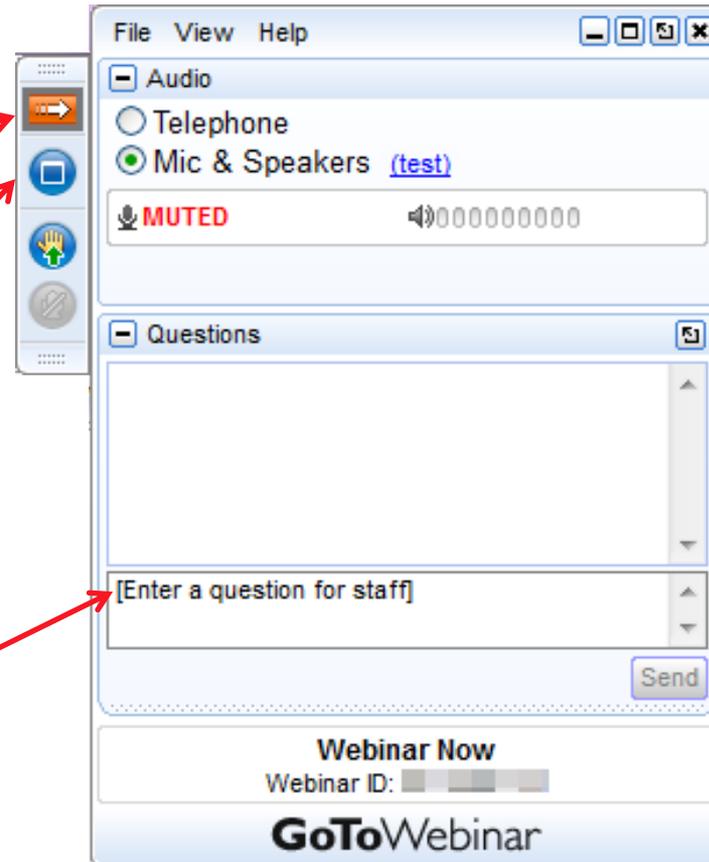
- John Mitchell, U.S. Environmental Protection Agency, Webinar Facilitator
- Kim Chaix, The Charcoal Project
- Saida Benhayoune, MIT, D-Lab Scale-Ups
- Sylvia Herzog, The Charcoal Project
- Dan Sweeney, Massachusetts Institute of Technology D-Lab
- Kendra Leith, Massachusetts Institute of Technology D-Lab

# Using the Webinar Technology

Hide Control  
Toolbar

Maximize  
Presentation

Question  
Feature



# Using the Webinar Technology

The image shows a screenshot of the GoToWebinar interface. The interface is divided into several sections: a top menu bar with 'File', 'View', and 'Help'; an 'Audio' section with options for 'Telephone' and 'Mic & Speakers (test)', a 'MUTED' status indicator, and a volume slider; a 'Questions' section with a text input field containing the placeholder '[Enter a question for staff]' and a 'Send' button; and a bottom section labeled 'Webinar Now' with a 'Webinar ID' field and the 'GoToWebinar' logo.

Three callout boxes with red arrows point to specific features:

- Maximize or Minimize:** Points to the maximize and minimize window control buttons in the top right corner of the interface.
- Type your question here, then click send:** Points to the text input field in the 'Questions' section.
- Pop-Out Feature:** Points to the pop-out icon (a square with a plus sign) in the top right corner of the 'Questions' section.

# Using the Webinar Polling Technology

The image shows a screenshot of a webinar polling interface. At the top, the word "QUICKPOLL" is displayed. Below it, the title "Test PCIA Polling Question" is shown. The instruction "Please select one:" is followed by five radio button options: "Answer A", "Answer B", "Answer C", "Answer D", and "Answer E". At the bottom right of the poll area is a "Submit" button. Two callout boxes with red borders and arrows provide instructions: one points to the question area and the other points to the "Submit" button.

The question will be listed here

Select one answer and then click "submit"

QUICKPOLL

**Test PCIA Polling Question**

Please select one:

- Answer A
- Answer B
- Answer C
- Answer D
- Answer E

Submit

# Purpose of the Webinar

- Why ICS enterprises might want to consider incorporating sustainable solid biomass fuel alternatives (fuel briquettes) into their business model.
- Discuss various business models for briquettes+ICS enterprises and the challenges and opportunities associated with each.
- Provide current examples of new, innovative briquetting technologies and practices being implemented in East Africa.
- Discuss initial results from a field survey conducted with customers of HFI-supported briquetting enterprises.

# Agenda

- Introduction
- Overview: Harvest Fuel Initiative
- The Business Side of Briquetting
- Technology
- Consumer Survey Results
- Lessons Learned and Recommendations
- How to participate in HFI
- Presenter Interaction/Q&A

# Questions to Consider

- The case for integrating solid biomass fuel alternative into ICS businesses:
- What challenges may an organization face in developing, manufacturing and/or promoting briquettes or briquetting technologies?
- What are some specific lessons and approaches from this webinar that can be applied to your local context to help you overcome these challenges?
- How can some of these business models and approaches be applied to other ICS and fuel technologies?

# Polling Question #1

What type of organization do you work for?

- a. NGO
- b. Private Cookstove and/or Fuels Producer or Distributor
- c. Private Sector - Other
- d. Government or Donor Organization
- e. Academic/Research

# Polling Questions #2

What type(s) of cooking technologies do you currently promote? Select all that apply.

- a. Improved charcoal stoves (household or institutional)
- b. Improved wood stoves (household or institutional)
- c. Other
- d. N/A, I do not promote specific cooking technologies

# Introduction: Harvest Fuel Initiative

## What:

*“The **Harvest Fuel Initiative** helps grow small businesses in the developing world that promote better fuels and clean combustion technologies for people who depend on wood and charcoal for their daily cooking and heating needs.”*

## Why:

Makes business sense (income)

Jobs

Health

Environmental protection

# Introduction: Harvest Fuel Initiative

## How:

HFI invests **technical, financial, and business management** resources in social enterprises that integrate clean tech and green fuels.

## Where:

Currently in East Africa.  
Expand to rest of SSA and Asia.

## Who:

The Charcoal Project  
+  
D-Lab's Scale-Ups Program at MIT

# Introduction: The Charcoal Project



1. Policy & Advocacy
2. Invest in scale-up and replicable solutions.
3. Nurture a global network of charcoal and briquette-making practitioners, policy-makers, academics.
4. *charcoalproject.org*

# Scale-Ups at D-Lab

- **D-Lab** is MIT's fast-growing and highly regarded educational and technology development program.
- **Scale-Ups** was created to identify and support technology-based ventures with potential for wide-scale poverty alleviation.
- **HFI** is our first large-scale technology transfer program.
- *[D-lab/mit.edu/scale-ups](http://D-lab/mit.edu/scale-ups)*

# Polling Question #3

How familiar are you with charcoal briquettes and briquette production technologies?

- a. Very familiar: actively producing and/or distributing
- b. Familiar: Have promoted in past or plan to in the future
- c. Somewhat familiar: Aware, but want to learn more
- d. Not familiar

# The Business Side of Briquetting

## HFI Enterprises

Who are they?

- Social enterprises building solid biomass fuel businesses

Why were they selected?

- Social mission: clear benefit for the environment, public health and poverty alleviation
- Integrated approach: sustainable feedstock, efficient conversion (carbonization), efficient combustion and reduced emissions during consumption
- Scalable or replicable, diversity of scale and business model
- Early stage but not start-up with proven desirability of product
- Leadership (management)
- Politically stable environments
- Appropriate technology

# The Business Side of Briquetting

## Issues to Consider

- **Location**
  - Rural: Access to feedstock
  - Urban: Access to customers
- **Organization**
  - Centralized vs decentralized production of char: control vs transportation trade-off
- **Technology**
  - Low tech: small capital investment, use of local labor pool
  - Medium tech: still relatively small investment with higher production output
  - High tech: high capital investment, ability to scale quickly
- **Profitability**
  - Needs to compete on price with traditional fuels
  - Important to leverage existing distribution channels to reduce marketing costs
  - Transportation costs for feedstock and final goods a key consideration
- **Market Acceptance**
  - Consumers willing to try a new product
  - Consumers willing to change cooking habits to achieve cost and health benefits
  - Cost of alternatives high enough that consumers are willing to switch

# Nakabale Integrated Development Group (NIDG)

- Community based group in Eastern Uganda
- Semi-rural area with ample access to agricultural waste which is provided by group members
- Smaller scale, uses MIT hand presses and oil drum kilns
- Centralized production of char (paid staff) and briquettes produced by members (paid in fuel and from group profits)



Key Attribute: Business model easily replicated with other groups.



# Teso Women Development Initiative (TEWDI)

- Non-profit org. for women owns a for-profit briquette making company.
- Semi-urban area with ample access to agricultural waste
- Medium size producer – 127 tons of briquettes in 2013 and 565 cookstoves, and growing rapidly.
- Modified meat grinder used for extruder, MIT/ARTI style kilns in use.
- Centralized production of char and briquettes.



Key Attribute- Quickly becoming financially sustainable with profits from briquette business used to support other social activities.



# Appropriate Rural Technology Institute – Tanzania (ARTI-TZ)

- ARTI-TZ is a non-profit with a for-profit briquette making company.
- Rural production of briquettes (near ag waste) with target market of Dar es Salaam.
- Decentralized collection of char and centralized production of briquettes
- Large scale potential, though initial growth has been hampered by equipment problems.
- Marketing strategy is to leverage off existing and new distribution networks for solar lighting and clean cookstoves.



Key attribute: large scale employment and income generation through decentralized char network.



# Green Bio Energy (GBE)

- Largest scale HFI enterprise
- Production and sales in Kampala (urban)
- Uses waste streams for feedstock (charcoal fines and organic waste)
- Customized briquetting technology
- Marketing success with middle-class consumers; now trying to reach BOP consumers.
- Branded products

Key Attributes: Large scale potential; urban production and distribution



# Polling Question #4

Which of the following do you currently produce/promote?

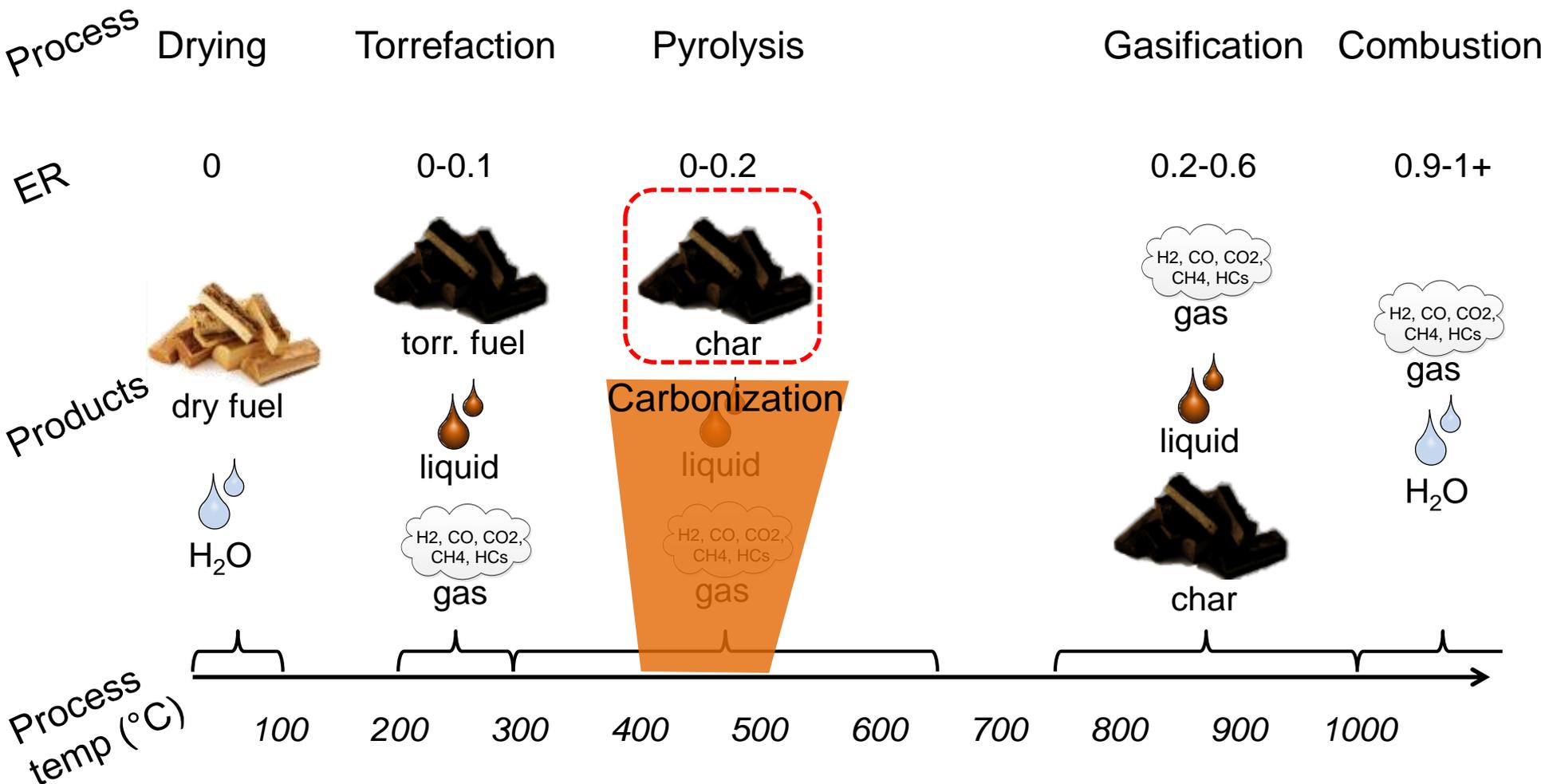
- a. Carbonized briquettes
- b. Non-carbonized briquettes
- c. Pellets
- d. Cookstove that uses alternative biomass fuels  
(any of the above)
- e. Other/NA

# Traditional Technology



*Traditional wood charcoal production in Liberia (Photo: BBC)*

# Thermal conversion



# Briquetting Feedstocks



	Sawdust	Maize cobs	Rice husks	Maize stalks	G'nut shells	Coconut shells	<i>Acacia mearnsii</i>
Proximate analysis	VM (wt%, dry)	76-86	80	64	74	74	84
	FC	13-19	19	18	19	22	15
	A	0.1-4.2	1	18	7	4	3
	HHV (MJ/kg)	19-20	18.8	16.1	17.7	18.6	20.1

VM = volatile matter, FC = fixed carbon, A = ash, HHV = higher heating value

Data reproduced from: Vassilev et al. (2010), Domalski et al. (1986)

# D-Lab Fuel from the Fields



Banzaert (2013)

# D-Lab's \$40 Briquetting Operation



*\$2 MIT D-Lab hand press (Uganda)*



*\$30-40 MIT D-Lab charcoal kiln, Haiti*

# Technical Challenges in Scaling Up

- Low-energy density, spatially dispersed feedstock
- Char processing- fine, abrasive
- Limited availability of suitable, low-cost tech.
- Expensive to import tech.
- Manufacturing consistency & product quality
- Seasonal variation in weather
- Space constraints and location
- Uniform and consistent products

# Feedstock Transport

- Low-density, dispersed materials → high transport cost
- Solution: decentralized carbonization
  - Densified – more economical for transport
  - Reduce processing at production site
  - Reduce air quality issues to production site
  - Income generation for farmers
  - Potential issues char quality



*Groundnut shell transport at TEWDI (Soroti, Uganda)*



*On-farm char production (near Dar es Salaam, TZ)*

- Research area: medium-scale, centralized advanced carbonization tech.

# Carbonization Technologies

- Spent oil drum – available nearly everywhere (\$20-40)
- Portable and modular
- Common designs: ARTI & D-Lab
- Carbonization (400-600°C, 0.5-4+ hrs)
- 5-20% solids yield



*D-Lab kiln (Uganda)*



*Shrub residue char (Tanzania)*



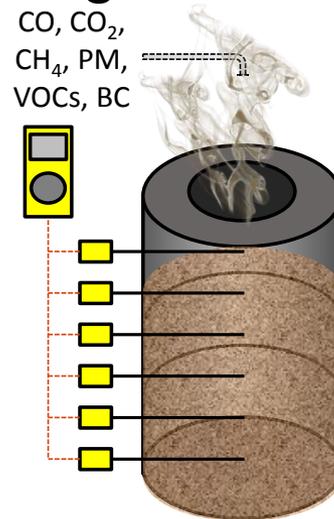
*Improved ARTI kiln (Uganda)*

# Improving Kiln Technology

- Problem: Low efficiency & harmful emissions
- Current improved kilns are expensive and/or difficult to operate
- HFI activity: Evaluate existing kiln efficiency & emissions

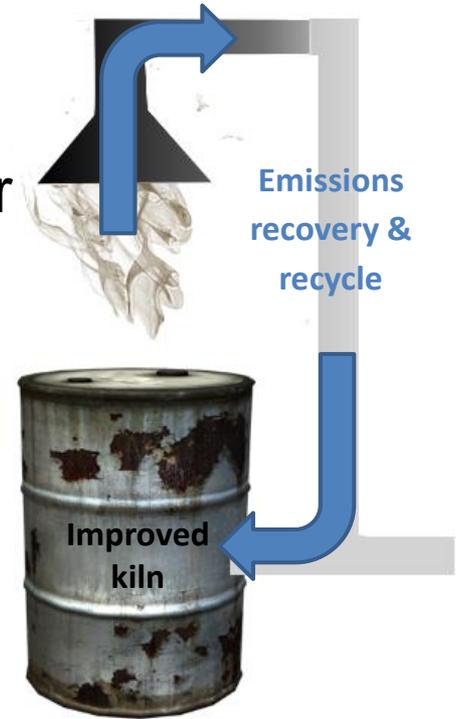


Volatile gas combustion in D-Lab kilns (Haiti)



*Kiln performance  
and emissions  
evaluation*

HFI research area: efficient,  
durable, low-cost, small-scale kiln



# Briquetting Technologies

- Small-scale: hand press
- Medium-scale: improvised extruder, multi-briquette press, Petersen press
- Large-scale: imported roller press, industrial extruder
- HFI research area: durable, 1-2 tpd briquetting machine

1 tpd briquette extruder at  
(TEWDI, Soroti, Uganda)



5 tpd piston press (GBE,  
Kampala, Uganda)



# Fuel Quality Control

- BOP consumers don't deserve poor quality products
- Variation in briquette product due to:
  - Type of feedstock
  - Binder-char mixture
  - Operator influence
  - Processing equipment
- HFI research area:
  - What fuel qualities correlate to consumer satisfaction?
  - What process parameters influence briquette quality?
  - How to measure and control?
  - Industry standards for fuel quality



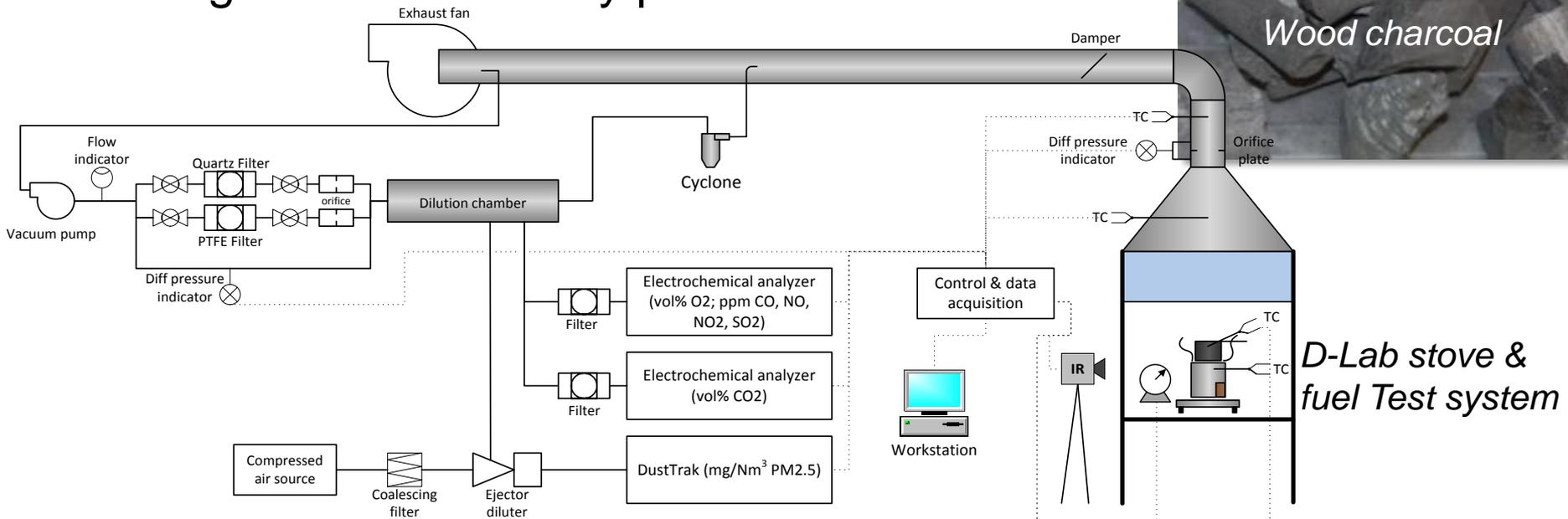
*Fully carbonized material*



*Partially carbonized residues*

# Fuel & Stove Evaluation

- Lab and field evaluations of cooking fuels & stoves
- Verify user insights and reactions
- Performance and emissions; comparison w/ other fuels
- Pairing of fuels w/ locally produced stoves



# Field Evaluation



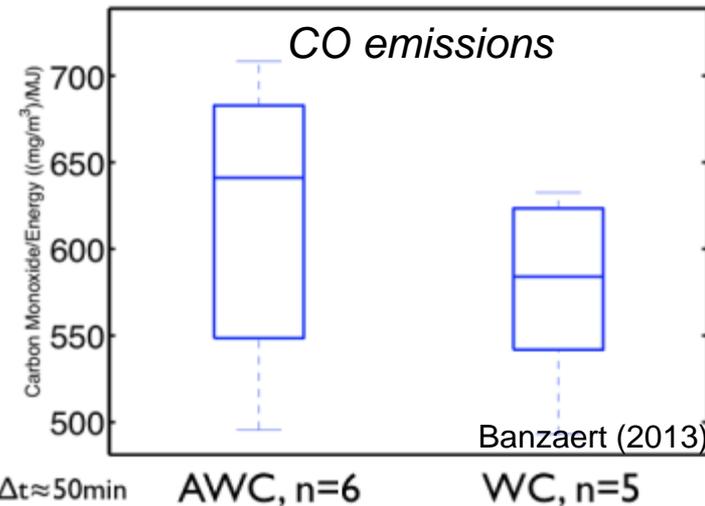
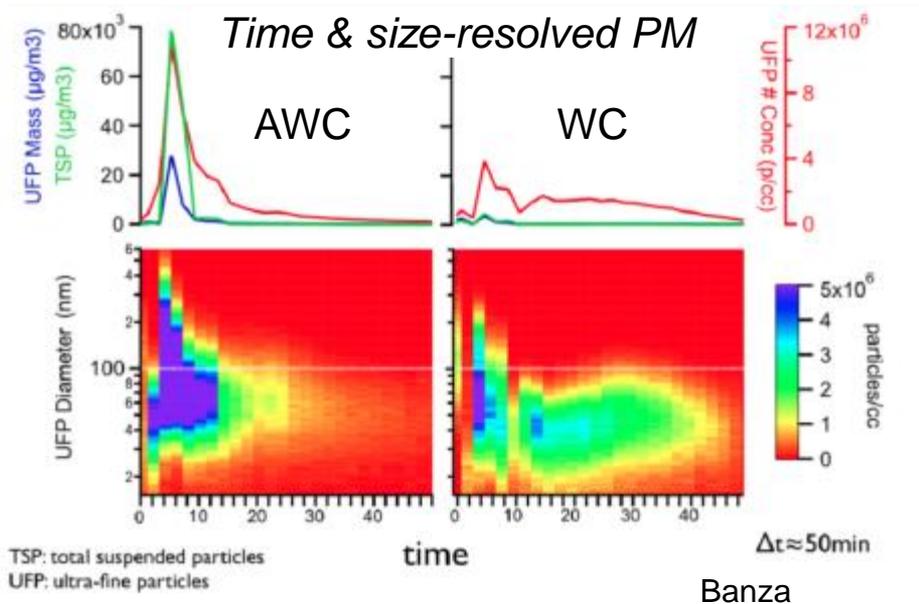
- Portable extractive hood sampling system (stove weight, CO<sub>2</sub>, CO, PM)
- Jan 2014, Uganda: 22 tests , 4 fuel and 4 stove combinations
  - Briquettes: lower heat output & reduced emissions

*Jan 2014 fuel evaluation*

	<b>3-Stone Fire</b>		<b>Wood-Charcoal</b>		<b>Charcoal Briquettes</b>	
	CS	HS	CS	HS	CS	HS
Time to boil (min)	10	9	22	10	26	15
Thermal efficiency (%)	16	11	13	18	8	22
Fuel use (g)	228	305	144	105	271	99
CO emissions (g)	23.6	42.4	30.6	18.6	48.2	16.3
PM emissions (mg)	6121	9298	65.1	29.8	36.8	4.2

# Lab Evaluation

- Extractive hood (~10 air changes/hr)
- Comparison of agri-residue briquettes and wood charcoal (Banzaert 2013)
- Quantities measured: stove weight, CO, CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub>, PM)
- HFI research plan:
  - Verification of field tests
  - Fuel/stove uncertainty distributions
  - Detailed aerosol characterization
  - Fuel quality studies



# Plea for Cooperation

- There is no silver bullet
- Solving technical challenges and developing an industry requires an open community of innovators



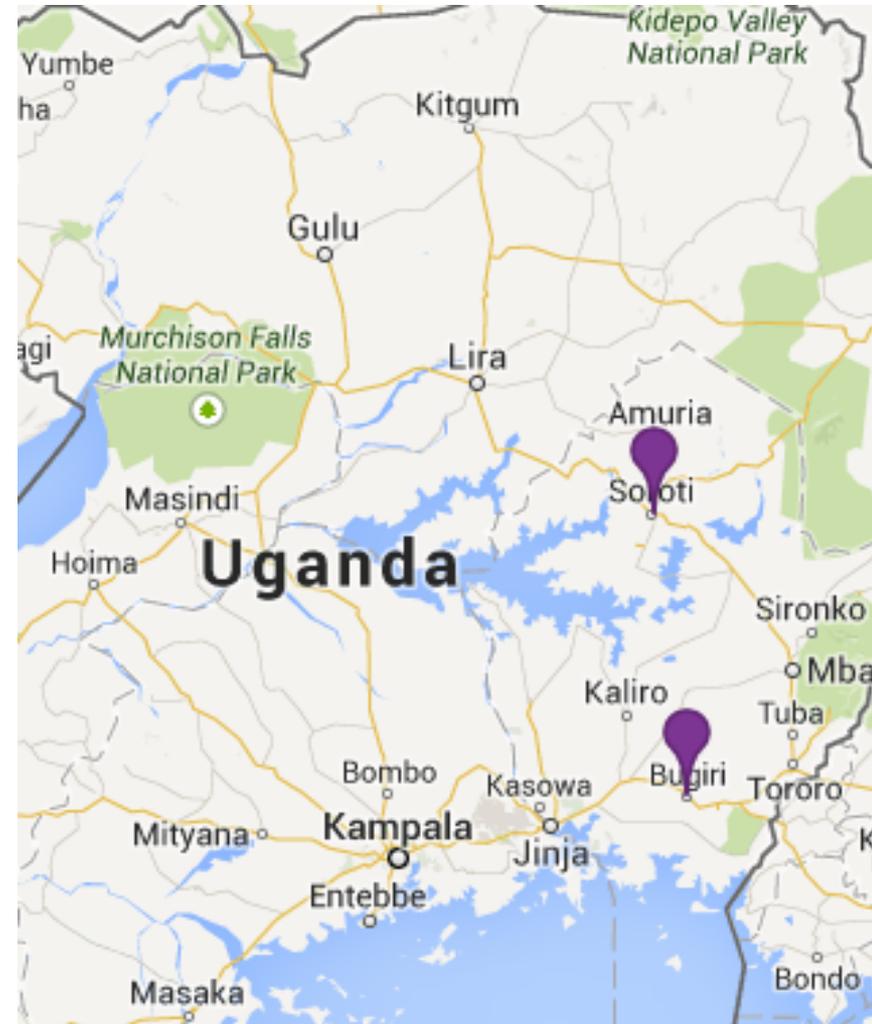
# Polling Question #5

What do you think is the biggest challenge in producing/promoting high quality charcoal briquettes?

- a. Limited market accessibility and penetration
- b. Capital needs (e.g., high cost of production technology)
- c. Availability of quality, consistent feedstock supply
- d. Low consumer awareness
- e. Other/NA

# Consumer Research: Context

- Soroti:
  - Briquettes from groundnut husks, char dust and saw dust
  - Sh.1000/kg
- Bugiri:
  - Briquettes from rice husks, bean stalks and shrub residues
  - Sh.1000-1400/kg



# Consumer Research: Overview

- Interviewed and observed 124 people
  - Soroti
    - Household users/non-users
    - Institutional users
    - Briquette/charcoal vendors
  - Bugiri
    - Household users/non-users
    - Institutional users
    - Briquette/charcoal vendors



# Consumer Research: Sampling

- Households in Bugiri and Soroti
  - Mapped out household users and randomly selected clients from each cluster
  - Matched users with non-users based on size of household and general income levels (standard of living)
- Institutions selected by Nakabale and AEST
- Vendors selected randomly from each cluster

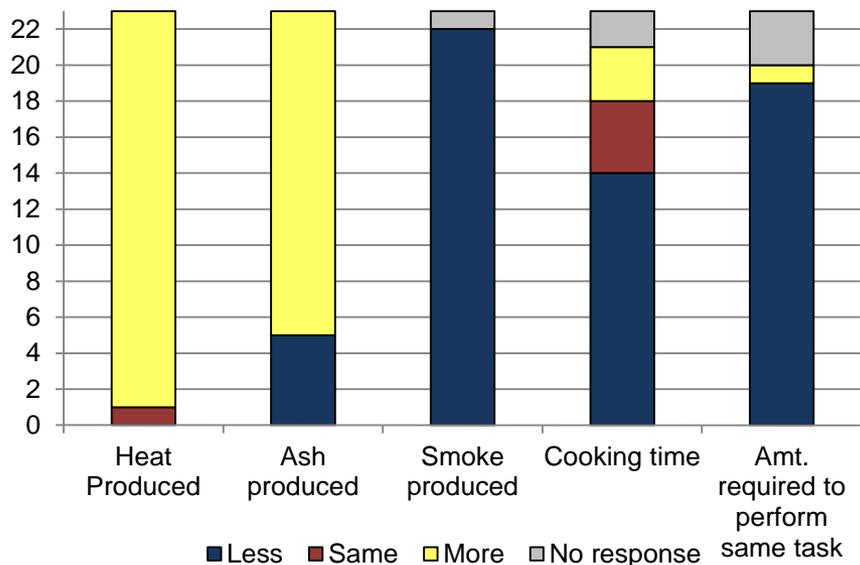


# Consumer Research: Major take-aways

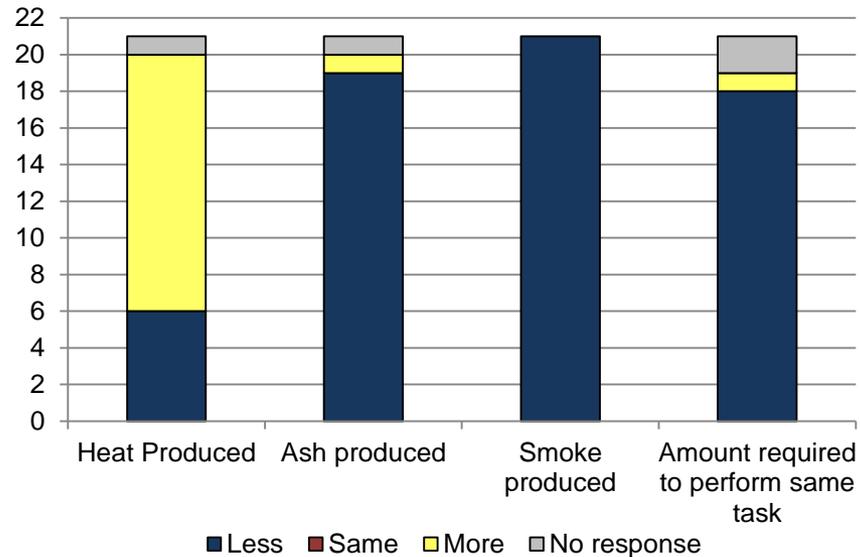
- In general, with the briquettes and the stoves, people reported the following changes:
  - Users are using less fuel and saving money on fuel
- Interviewees also reported the following changes as a result of the:
  - Briquettes
    - Cleaner kitchens
    - Longer burning charcoal
    - Less smoke in the kitchen
    - Less need to add charcoal
    - Less tending to the fire
    - Faster cooking
  - AEST stoves
    - Faster cooking
    - Better insulation
    - Consistent heat

# Households: briquettes in comparison to wood charcoal

Households: AEST charcoal in comparison to wood charcoal

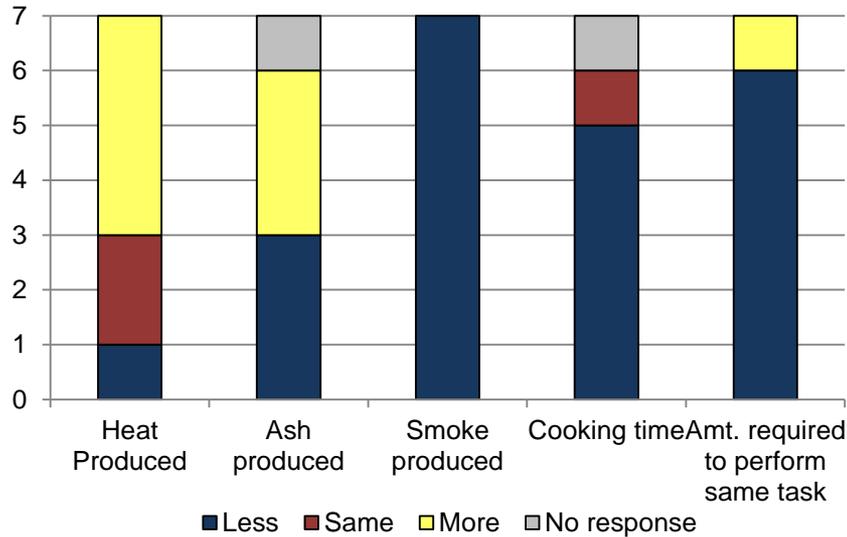


Households: Nakabale charcoal in comparison to wood charcoal

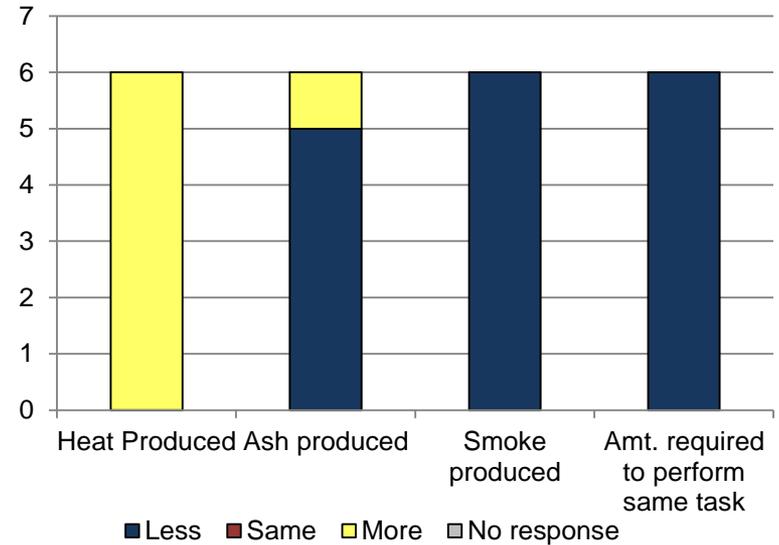


# Institutions: briquettes in comparison to wood charcoal

Institutions: AEST charcoal in comparison to wood charcoal

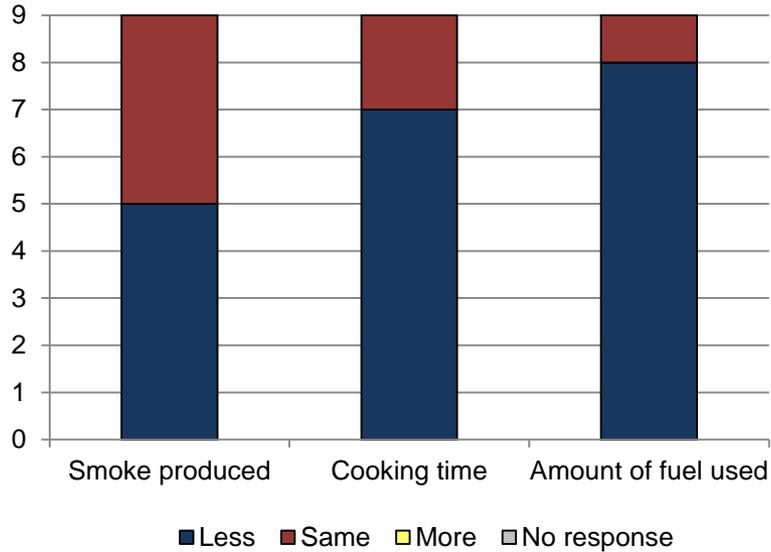


Institutions: Nakabale charcoal in comparison to wood charcoal

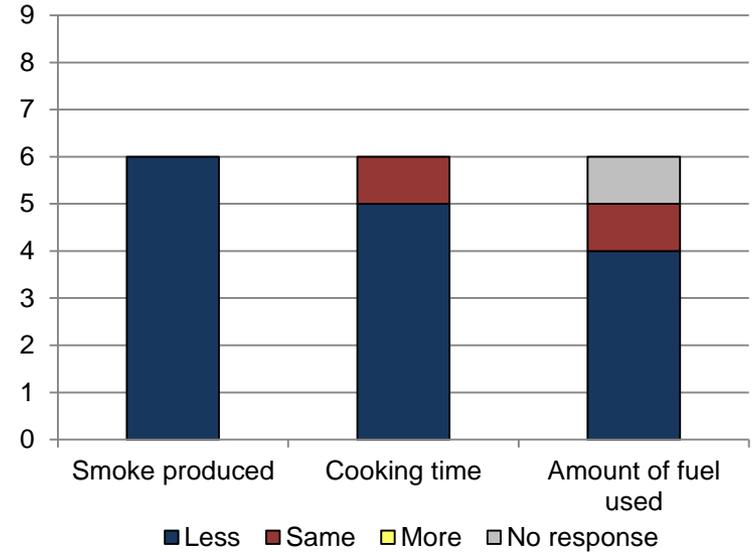


# AEST stoves in comparison to previous cookstoves

Households: AEST stoves in comparison to previous stoves



Institutions: AEST stoves in comparison to previous stoves



# Major take-aways

- Overall, users are satisfied with the briquettes and stoves
  - However, there are some small changes that can be made to the briquettes
    - Make briquettes easier to light
    - Create more standard sizes
    - Reduce or reuse ash
    - Include labels with how the briquettes are made
    - Make the briquettes compact, stronger and harder
    - Produce smaller packets of briquettes
    - Set-up training to make briquettes
    - Increase supply and accessibility

## **Why does integrating sustainable fuels make sense?**

- Good for bottom line
- Good for consumer pocketbooks
- Potentially healthier for consumers
- May displace unsustainably harvested and inefficiently produced charcoal
- Reduced Greenhouse Gas emissions
- Provides farmer with additional income
- Creates jobs for marginalized groups

## **Key things to consider when entering this business:**

- **Different business models**
  - Urban vs rural location, centralized vs decentralized production, scale of production
- **Main challenges**
  - Market penetration, capital investment, availability of feedstock, distance to market, selection of appropriate technology, product quality, low margin

# Resources Available

- [www.harvestfuel.org](http://www.harvestfuel.org)
  - Forum
  - Resources
  - Webinars
  - Subscribe to updates
  - Scheduled forum webinar follow-up discussion:  
Wednesday, March 26<sup>th</sup>, 10:00 am
- Apply for participation in HFI
  - You can engage even if you are not a HFI enterprise

# Contact Information

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# Questions and Answers

To ask a question, please type in your question in the Questions/Chat pane on your webinar console.

# Next Steps

## Following the webinar...

- The presentation and answers to your questions will be posted to <http://www.epa.gov/cookstoves>
- Please complete the Survey Monkey Evaluation you will receive shortly

## Let us know...

- What surprised/interested you most about what you heard from the presenters?
- What information would you like to hear more about?
- What other topics would you like to see presented in the future?